Operating and Service Manual

MODEL

60S1G3

PART NUMBER

1010643-501

SERIAL NUMBER

300262

AMPLIFIER RESEARCH
Souderton, PA 18964-9990 USA
TEL 215-723-8181 TWX 510-661-6094 FAX 215-723-5688

AMPLIFIER RESEARCH

160 School House Road, Souderton, PA 18964-9990 USA
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EC Declaration of Conformity

We; Amplifier Research
160 School House Road
Souderton, Pa. 18964

declare that as of 1997, our product(s);

the Model 60S1G3 series amplifiers

to which this declaration relates is in compliance with the requirements of the EEC EMC Directive (89/336/EEC) and Low Voltage Directive (73/23/EEC) in accordance with the relative standards listed below:

EMC:

EN 50082-2 : 1995
Electromagnetic compatibility - Generic immunity standard
Part 2: Industrial environment

EN 55011 : 1991
Electromagnetic emissions requirements for Industrial, Scientific and Medical (ISM) Equipment
Group 1, Class A

Safety:

IEC 1010-1 : 1990 + A1, A2

The CE marking is affixed on the device according to the EC Directives.

Donald R. Shepherd

Donald R. Shepherd
President

⚠ INSTRUCTIONS FOR SAFE OPERATION

BEFORE APPLYING POWER

Review this manual and become familiar with all safety markings and instructions.

Verify that the equipment line voltage selection is compatible with the main power source.

Protection provided by the equipment may be impaired if used in a manner not specified by Amplifier Research.

INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications. It is designed to be used in the process of generating, controlling, and measuring high levels of electromagnetic Radio Frequency (RF) energy. Therefore, the output of the amplifier must be connected to an appropriate load, such as an antenna or field-generating device. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of the RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the amplifier. Do not come into contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating condition before disconnecting or connecting the load to the RF output connector.

SAFETY GROUND

This equipment is provided with a protective earth terminal. The main power source to the equipment must supply an uninterrupted safety ground of sufficient size to the input wiring terminals, power cord, or supplied power cord set. The equipment **MUST NOT BE USED** if this protection is impaired.

PHYSICAL DAMAGE

The RF amplifier should not be operated if there is physical damage, missing hardware, or missing panels.

MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment, even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

INSTRUCTIONS FOR SAFE OPERATION *(continued)*

SAFETY SYMBOLS

This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information. This symbol is indicated in the "Table of Contents" to assist in locating pertinent information.

Dangerous voltages are present. Use extreme care.

CAUTION: The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.

Indicates protective earth terminal.

RANGE OF ENVIRONMENTAL CONDITIONS

This equipment is designed to be safe under the following environmental conditions:

Indoor use

Altitudes up to 2000M

Temperature of 5°C to 40°C

Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearity to 50% at 40°C.

Mains supply voltage fluctuations not to exceed ±10% of the nominal voltage or minimum and maximum autoranging values.

Pollution degree 2: Normally non-conductive with occasional condensation

While the equipment will not cause hazardous condition over this environmental range, performance may vary.

COOLING AIR

Care should be exercised not to block the cooling air inlets or outlets. Cooling air blockage can result in damage to the RF amplifier or intermittent shut-downs.

SECTION I

GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

The Model 60S1G3 is a self-contained, broadband microwave amplifier designed for laboratory applications where instantaneous bandwidth, high gain, and moderate power output are required. A "GAIN" control, located on the front panel, can be used to decrease the amplifier gain by 10 decibels (dB) or more. Solid state technology is used exclusively to offer significant advantages in reliability and cost. A Model 60S1G3, when used with a frequency-swept signal source, will provide 60 watts of swept power output from 0.8–3.0GHz. Typical applications include antenna and component testing, wattmeter calibration, and electromagnetic interference (EMI) susceptibility testing, as well as usage as a driver for frequency multipliers and high-power amplifiers. The Model 60S1G3 can be operated locally by using the front panel controls, or remotely by using either an IEEE-488 or RS-232 interface.

1.2 POWER SUPPLIES

The Model 60S1G3 contains switching power supplies. The input voltage range to the power supplies is 90–132 or 180–264 Volts Alternating Current (VAC), 50/60Hz, selected automatically. The operator does not have to switch or change anything on the Model 60S1G3 when changing the AC input voltage. AC power consumption is 600 watts nominal. A built-in circuit breaker provides primary AC circuit protection.

1.3 SPECIFICATIONS

Refer to the "Amplifier Research Data Sheet" on the following page for detailed specifications. All voltage measurements referenced in this manual are Direct Current (DC) unless stated otherwise.

AMPLIFIER RESEARCH
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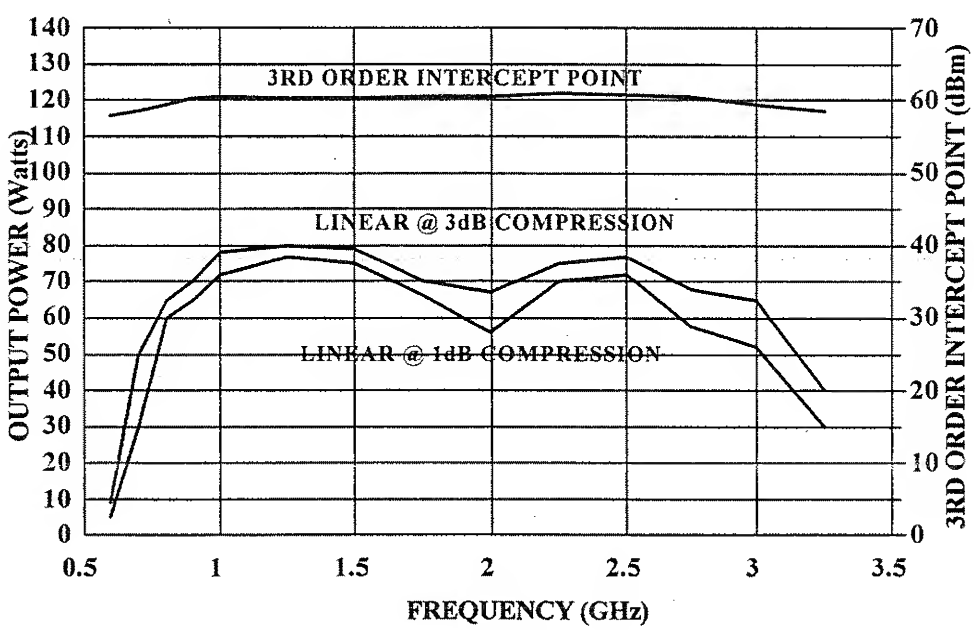
MODEL 60S1G3
M1, M2, M3, M4
60 WATTS CW
0.8 - 3.0 GHz

The Model 60S1G3 is a solid state, self-contained, air-cooled, broadband amplifier designed for applications where instantaneous bandwidth, high gain and linearity are required. Housed in a stylish contemporary cabinet, the unit is designed for benchtop use, but can be removed from the cabinet for immediate equipment rack mounting.

The 60S1G3, when used with a sweep generator, will provide a minimum of 60 watts of RF power. Included is a front panel gain control which permits the operator to conveniently set the desired output level. The 60S1G3 is protected from RF input overdrive by an RF input leveling circuit which controls the RF input level to the RF amplifier first stage when the RF input level is increased above 0 dBm. The RF amplifier stages are protected from over-temperature by removing the DC voltage to them if an over-temperature condition occurs due to cooling blockage or fan failure. There is a digital display on the front panel to indicate the operate status and fault conditions if an over-temperature or power supply fault has occurred. The unit can be returned to operate when the condition has been cleared. The 60S1G3 digital panel provides control of all amplifier functions both locally and remotely via IEEE-488 (GPIB) or RS-232 interfaces.

The low level of spurious signals and linearity of the Model 60S1G3 make it ideal for use as a driver amplifier in testing wireless and communication components and subsystems. It can be used as a test instrument covering multiple frequency bands and is suitable for a variety of communication technologies such as CDMA, W-CDMA, TDMA, GSM etc. It is also suitable for EMC Test applications where undistorted modulation envelopes are desired.

60S1G3
Typical Performance



REV060800

RATED POWER OUTPUT .... *60 watts minimum*
47.78dBm

INPUT FOR RATED OUTPUT .... *1.0 milliwatt*
.... *maximum*

POWER OUTPUT @ 3dB COMPRESSSION
Nominal .... *70 watts*
Minimum .... *60 watts*

POWER OUTPUT @ 1dB COMPRESSION
Nominal .... *60 watts*
Minimum .... *50 watts*

FLATNESS .... *±1.5 dB typical*
.... *±2.0 dB maximum*

FREQUENCY RESPONSE .... *0.8 - 3.0 GHz*
.... *instantaneously*

GAIN (at maximum setting) .... *48 dB minimum*

GAIN ADJUSTMENT ....*(Continuous Range)*
....*10 dB minimum*
.... *(4096 steps remote)*

INPUT IMPEDANCE .... *50 ohms*
.... *VSWR 2.0:1 maximum*

OUTPUT IMPEDANCE .... *50 ohms, nominal*

MISMATCH TOLERANCE

100% of rated power without foldback. Will operate without damage or oscillation with any magnitude and phase of source and load impedance. (See Application Note #27)

MODULATION CAPABILITY

Will faithfully reproduce AM, FM, or pulse Modulation appearing on the input signal

THIRD ORDER INTERCEPT

See chart. The third order intercept points for this chart have been determined using two tones spaced 1 MHz apart. This is typical for W-CDMA systems. Closer tone spacing such as 60 kHz generally provides about a 1db to 3db improvement in the IP.

HARMONIC DISTORTION ....*Minus 20 dbc*
....*max at 50 watts*

SPURIOUS .... *Minus 73 dbc Typ.*

PHASE LINEARITY .... *± 1.0 deg/100 MHz, Typ*

PRIMARY POWER .... *(Selected Automatically)*
.... *90-132, 180-264 VAC*
....*50/60 Hz, single phase*
.... *600 watts maximum*

CONNECTORS
RF .... *Type N female*
REMOTE INTERFACES
IEEE-488 ....*24 pin*
RS-232 ....*9 pin Subminiature D*

SAFETY INTERLOCK .... *15 pin Subminiature D*

COOLING .... *Forced air (self contained fans)*

MODEL CONFIGURATIONS

MODEL NUMBER	RF INPUT	RF OUTPUT	WEIGHT	SIZE(WxHxD
60S1G3	Type N female on front panel	Type N female on front panel	45 kg (100 lbs)	50.3 x 24.9 x 54.6 cm 19.8 x 9.8 x 21.5 in
60S1G3M1	Type N female on rear panel	Type N female on rear panel	45 kg (100 lbs)	50.3 x 24.9 x 54.6 cm 19.8 x 9.8 x 21.5 in
60S1G3M2	Same as 60S1G3 with enclosure removed for rack mounting		32 kg (71 lbs)	48.3 x 22.2 x 54.6 cm 19.0 x 8.75 x 21.5 in
60S1G3M3	Same as 60S1G3M1 with enclosure removed for rack mounting		32 kg (71 lbs)	48.3 x 22.2 x 54.6 cm 19.0 x 8.75 x 21.5 in
60S1G3M4	Same as 60S1G3M2 except the gain control knob is removed and a lock is installed		32 kg (71 lbs)	48.3 x 22.2 x 54.6 cm 19.0 x 8.75 x 21.5 in

SECTION II

OPERATING INSTRUCTIONS

2.1 GENERAL

Operation of the Model 60S1G3 broadband microwave amplifier is simple. The input signal, whether swept or fixed in frequency, is fed into the jack marked **"INPUT"** and the amplifier output signal is taken from the jack labeled **"OUTPUT."** The unit is turned "ON" by activating the power switch. A circuit breaker in the AC line provides protection in the event of a unit malfunction. A polarized, three (3)-wire AC power cord is also included with the unit to provide cabinet and chassis grounding to the power mains.

⚠ CAUTION:

OPERATION OF THE MODEL 60S1G3 AMPLIFIER IS NOT CRITICALLY AFFECTED BY SOURCE AND LOAD VOLTAGE STANDING-WAVE RATIO (VSWR), AND THE UNIT WILL REMAIN UNCONDITIONALLY STABLE UNDER ANY MAGNITUDE AND PHASE CONDITIONS OF SOURCE AND LOAD. THE MODEL 60S1G3 HAS ALSO BEEN DESIGNED TO WITHSTAND RF INPUT POWER LEVELS AS HIGH AS 20mW—TWENTY (20) TIMES ITS RATED INPUT POWER LEVEL OF 1mW—WITHOUT SUSTAINING DAMAGE. HOWEVER, RF INPUT POWER LEVELS GREATER THAN 20mW OR TRANSIENTS WITH HIGH PEAK VOLTAGES CAN DAMAGE THE AMPLIFIER. ALSO, ACCIDENTAL CONNECTION OF THE MODEL 60S1G3's OUTPUT TO ITS INPUT CAN CAUSE OSCILLATIONS THAT WILL PERMANENTLY DAMAGE THE UNIT'S INPUT CIRCUITRY.

IMPORTANT NOTE:

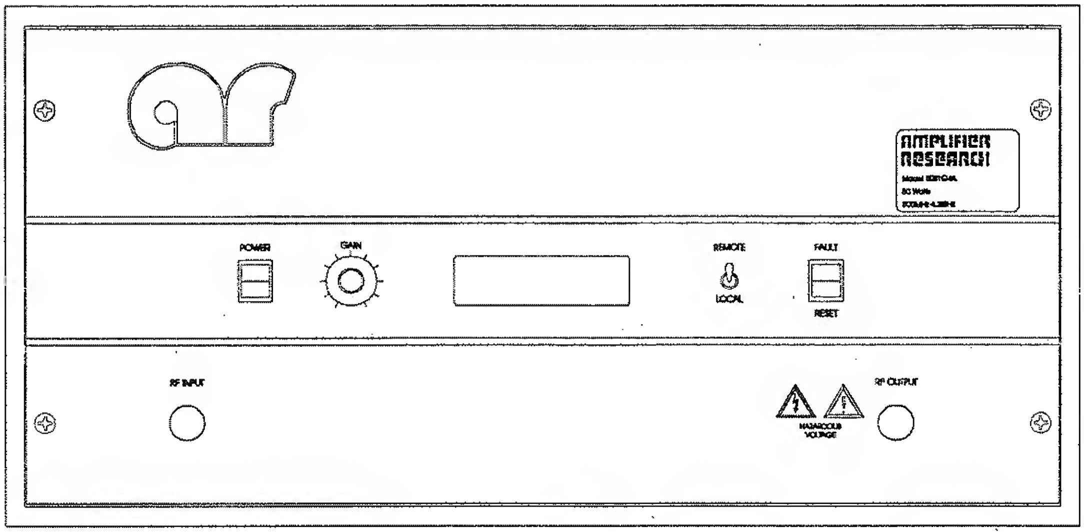
ALTHOUGH THE MODEL 60S1G3 IS DESIGNED TO OPERATE WITHIN THE OVERDRIVE AND LOAD TOLERANCE CONDITIONS DESCRIBED ABOVE, SUBJECTING THE AMPLIFIER TO THESE CONDITIONS SIMULTANEOUSLY CAN CAUSE FAILURE OF THE UNIT'S OUTPUT TRANSISTORS. REPEATED FAILURES OF THIS NATURE WILL NOT BE COVERED UNDER THE UNIT'S WARRANTY.

The Model 60S1G3 Amplifier is protected from input overdrive by an Automatic Level Control (ALC) Circuit that limits the maximum RF level to the first gain stage (Q1) of the RF Amplifier to approximately 0dBm.

The Model 60S1G3's RF power transistors are protected from over-temperature by a sensor that senses the heat sink temperature near the RF output transistors. In the event of a cooling fan failure or an air flow blockage, the DC voltage will be removed from the RF stages; if and when the heat sink temperature reaches approximately 70°C. The (VFD) vacuum flourescent display on the unit's front panel will indicate "Thermal Fault". Normal operation can be resumed by resetting the amplifier after the heat sink temperature drops below 70°C.

2.2 AMPLIFIER OPERATION

Figure 2-1 shows the front panel of the Model 60S1G3 Broadband Microwave Amplifier.



2.2.1 Local Operation

Power-up Sequence:

1. Connect input signal to "INPUT" connector. **The input signal level should be 0dBm maximum.**

2. Connect load to "**OUTPUT**" connector.

3. Set the "**LOCAL/REMOTE**" switch to "**LOCAL.**"

4. Check to see that the MAIN POWER switch (circuit breaker) on the unit's rear panel is set to the 1 ("on") position.

5. Press the "**POWER**" switch: the front panel vacuum fluorescent display (VFD) should read POWER ON, STATUS PK when power is applied.

   (NOTE: The Amplifier changes state each time the "POWER" switch is depressed—if the unit is on when the POWER switch is depressed, it will turn off; if the unit is off when the POWER switch is depressed, it will turn on.)

6. Adjust the gain by rotating the "**GAIN**" knob.

7. In the event of a Fault, press the "**RESET**" switch. If the problem persists, refer to Section 4.3 ("Troubleshooting") of this manual.

2.2.2 Remote Operation

2.2.1.1 Introduction

This subsection describes remote operation of the Model 60S1G3 amplifier by utilizing either the IEEE-488 parallel interface or the RS-232 serial interface and a controlling device, such as a bus controller or a personal computer (PC).

2.2.2.2 Selecting Remote Operation

The Model 60S1G3 can be placed in remote state at any time by switching the "**REMOTE/LOCAL**" switch on the front panel to the "**REMOTE**" position. In this mode, control is transferred to the selected remote interface and all the front panel controls are inoperative with the exception of the **REMOTE/LOCAL** switch. The amplifier's initial state will be **Power Off**, Minimum Gain. The front panel VFD will indicate **REMOTE** until the unit is returned to the local operation mode.

2.2.2.3 Interface Selection

The Model 60S1G3 can be controlled via either the IEEE-488 or RS-232 interfaces. Which interface is active is determined by the position of Switch 6 of the rear panel dual-in-line package (DIP) switch located between the two interface connectors. If Switch 6 is in the "on" (1) position, the active interface will be the RS-232. The "off" (0) position will activate the IEEE-488 interface.

2.2.2.4 Interface Set-up

Switches 1–5 of the rear panel DIP switch are used to select either the RS-232 communication (BAUD) rate or the IEEE-488 device address, depending upon which interface is active. (**NOTE:** These switches are only read at device power-up. In order for changes made in these switch settings to take place, AC power must be removed and then re-applied to the Model 60S1G3.)

2.2.2.4.1 RS-232 BAUD rate selection

The serial communication (BAUD) rate can be set to five different levels. Selections are made by the positions of Switches 1–5 of the rear panel DIP switch. The following is a list of the available BAUD rates and the corresponding switch positions:

BAUD Rate	Switch on (1)
1200	1 only
2400	2 only
9600	3 only
19600	4 only
76800	5 only

(NOTE: Any other combination of switch settings will result in a BAUD rate equal to 1200.)

2.2.2.4.2 IEEE-488 device address selection

The IEEE-488 device address can be set to any number between 1 and 30. This selection is made by setting Switches 1–5 of the rear panel DIP switch to the binary equivalent of the number. **Table 2-1** illustrates this switch selection.

Table 2-1: IEEE-488 Device Address Selection

Device Address	Switch 5	Switch 4	Switch 3	Switch 2	Switch 1
1	off (0)	off (0)	off (0)	off (0)	on (1)
2	off (0)	off (0)	off (0)	on (1)	off (0)
3	off (0)	off (0)	off (0)	on (1)	on (1)
4	off (0)	off (0)	on (1)	off (0)	off (0)
5	off (0)	off (0)	on (1)	off (0)	on (1)
:					
:					
30	on (1)	on (1)	on (1)	on (1)	off (0)

2.2.2.5 Command Set Format

Each command is composed of one alpha character, up to four numeric parameters, and a command termination character. The command termination character is the "line feed" command, which is denoted and entered as <LF>. Commands are case-sensitive and must be entered in upper case only in order to be recognized.

2.2.2.6 IEEE-488 Communications

For IEEE-488 communications, the "End or Identify" (EOI) control line may also be used for command termination. When sending commands to the Model 60S1G3 via the IEEE-488 bus, terminate each command with a <LF>, an EOI, or both. No characters are permitted after the <LF> or EOI; the 60S1G3 interprets characters following the <LF> or EOI as the start of the next command. When an error condition is present at the Model 60S1G3, the "Service Request" (SRQ) line is asserted. The operator can then perform a serial poll operation. The Model 60S1G3 error code (in binary) is contained in the returned serial poll status byte (STB). These error codes are defined in **Table 2-2.**

TABLE 2-2: REMOTE ERROR CODES/MESSAGES

IEEE-488 SERIAL POLL RESPONSE (STB) (binary)/decimal	MODEL 60S1G3 ERROR CONDITION	RS-232 ERROR MESSAGE
(01000001) 65	BAD COMMAND	E1
(01000010) 66	BAD PARAMETER	E2
(01000011) 67	INTERLOCK FAULT	E3
(01000100) 68	THERMAL FAULT	E4
(01000101) 69	POSITIVE 15 VOLT FAULT	E5
(01000110) 70	POSITIVE 16.5 VOLT FAULT	E6
(01000111) 71	NEGATIVE 5 VOLT FAULT	E7
(01001000) 72	NEGATIVE 15 VOLT FAULT	E8
(01001001) 73	AMP FAULT	E9
************	TRANSMISSION	E10

2.2.2.7 RS-232 Communications

If RS-232 is the active interface, the Model 60S1G3 will test for a properly connected RS-232 interface when switched into remote mode. In order for the Model 60S1G3 to recognize an RS-232 connection, the "Data Carrier Detect" (DCD) line must be asserted. This line is sampled continuously to determine if the RS-232 connection is broken; therefore, it must remain asserted in order for the RS-232 interface to function. The "Clear To Send" (CTS) line is also used to gate information from the Model 60S1G3. This line must be asserted in order to receive information from the Model 60S1G3. The CTS line can be used as a "handshake" line to inform the Model 60S1G3 when it is permissible to send information. If the CTS line is de-asserted in the middle of a transmission, the character in the process of being transmitted will be completed and further transmission will halt until the CTS line is re-asserted. The Model 60S1G3 itself asserts two lines—"Data Terminal Ready" (DTR) and "Request To Send" (RTS). The DTR line is continuously asserted, while the RTS line is used to gate information into the Model 60S1G3. Connector pin-out information is given in **Table 2-3**.

TABLE 2-3: RS-232 CONNECTOR PIN-OUTS

Pin No.	Signal	Data Direction*	Description
1	DCD	<	Device Carrier Detect
2	RD	<	Receive Data
3	TD	>	Transmit Data
4	DTR	>	Data Terminal Ready
5	GND	N/A	Ground
6	NC	N/A	No Connection
7	RTS	>	Ready To Send
8	CTS	<	Clear To Send
9	NC	N/A	No Connection

*Note:
> Output from Model 60S1G3
< Input to Model 60S1G3

Special Note: A null modem cable or adapter is required in order to properly interface the Model 60S1G3 to a standard serial port on a computer.

Once the RS-232 interface is established, commands are processed in the same manner as that of the IEEE-488 interface. The command structure is identical except that there is no EOI line. Therefore, all commands are terminated with a line feed (<LF>). Since this is a full-duplex asynchronous interface, if the Model 60S1G3 detects an error, the error message is immediately transmitted to the host controller. These error messages are defined in **Table 2-2.**

2.2.2.7.1 RS-232 port settings

The RS-232 port settings used for communication with the Model 60S1G3 are as follows.

Word Length:	8 bits
Stop Bits:	1
Baud Rate:	1200–76,800 (switch-selectable)
Parity:	None

2.2.2.8 Remote Commands

The following commands are available to the user for remote communication and operation of the Model 60S1G3. In the descriptions of these commands, a lower-case "x" is used to signify a numeric value or parameter.

2.2.2.8.1 POWER ON/OFF

Controls the power on/off state of the Model 60S1G3.

Syntax: Px

Parameters: 0 = power off

1 = power on

Example: To turn the power on, send the following command:

P1<LF>

2.2.2.8.2 GAIN

Sets the remote gain level of the Model 60S1G3 with 4095 steps of resolution.

Syntax: Gxxxx

Parameters: 0000 = maximum gain

:

:

4095 = minimum gain

Example: To set the Model 60S1G3 to minimum gain, send the following command:

G4095<LF>

2.2.2.8.3 RESET

Resets the Model 60S1G3, clearing all Faults, if possible.

Syntax: R

Parameters: None

Example: To clear a Fault, send the following command:

R<LF>

SECTION III

THEORY OF OPERATION

3.1 INTRODUCTION

The Model 60S1G3 Microwave Amplifier consists of a 0.8–3.0 gigahertz (GHz) RF Amplifier located on the heat sinks and a Power Supply/Operate/Fault Circuit mounted on a chassis assembly located opposite the output heat sink. The RF Amplifier assemblies can be accessed through the top or bottom of the unit, and the Power Supply and Operate/Fault Circuits can be accessed through the bottom of the unit.

The RF Amplifier assembly consists of a Variable Gain Amplifier, a Splitter/Detector, a Linearizer/Control Circuit, a One (1)-watt Amplifier, a Bias Control Circuit, a driver stage, a Two-Way Splitter, two more driver stages, two Four-Way Splitters, eight output stages, and an Eight-Way Combiner.

The Power Supply section consists of an AC input filter, a circuit breaker, two switching power supplies, an Operate/Control Circuit, and a Regulator/Fault Circuit.

3.2 RF AMPLIFIER OPERATION

3.2.1 A1 Variable Gain Amplifier (Schematic No. 1008812—Part of Schematic No. 1008816)

The RF input signal is fed to the A1 Variable Gain Amplifier, RF Attenuator U1. U1 is a Gallium Arsenide (GaAs) Field-Effect Transistor (FET) Attenuator. DC signals between approximately -0.5V to -2.0V are used to control the shunt and series legs of the RF Attenuator. This Attenuator is used for manual gain control using the front panel "GAIN" control or for remote gain control, and to attenuate RF input signals above 0dBm, by utilizing internal voltages.

Inductor–Capacitor (LC) networks C2, L1, C3, and L2 form high-pass filters that are used to attenuate low-frequency signals.

Transistor Q1 is a GaAs FET and is the first stage of gain in the amplifier. Transistor A3Q1 in the A3 Linearizer Control Circuit controls the drain current through FET Q1. The output of Q1 is fed to the input of the Wilkinson Two-Way Splitter.

The Wilkinson Two-Way Splitter splits the signal into two paths. One output is fed to the input of the A4 One (1)-Watt Amplifier. The other output is fed to a detector that is terminated in 50Ω. The detected output is fed to the A3 Linearizer Control Circuit.

3.2.2 A3 Linearizer Control Circuit (Schematic No. 1007392—Part of Schematic No. 1008816)

Integrated circuit (IC) U1A provides a DC signal to the series element of the A1U1 Attenuator. The A1U1 has minimum attenuation when the control signal is at approximately -12.5V with maximum attenuation (minimum gain) occurring with 0V on the control input.

3.2.2 A3 Linearizer Control Circuit *(continued)*

NPN transistors Q2, Q3, and Q4 are used to provide break points in the series control voltage to the A1U1 RF Attenuator, thereby providing a more linear gain control/attenuation characteristic. IC U1B maintains the output impedance of the A1U1 RF attenuation near 50Ω. U1B is a comparator; a reference voltage is developed across a 56Ω resistor (R22) connected to the non-inverting input. The inverting input is connected to the output of the RF Attenuator A1U1 through A1L2. If the DC voltage at the output of the RF Attenuator becomes more negative, the output from the comparator will become more positive, thereby decreasing the output impedance of the A1U1 Attenuator and maintaining the correct output impedance.

PNP transistor Q1 is used to control the drain current of GaAs FET A1Q1 by varying the A1Q1 gate voltage. A reference voltage is provided at the base of Q1 by voltage dividers R25 and R26. The drain current of the RF FET (A1Q1) flows through R27 (220Ω, 1 watt). PNP transistor Q1 varies the gate voltage to the RF FET A1Q1 to maintain the correct drain current.

IC U2A amplifies the signal from the A1CR1 detector diode. IC U2B is a comparator; its normal output is approximately -12.5V. When the RF input signal to the A1 Variable Gain Amplifier is increased above approximately 1mW (0dBm), the voltage output from U2B will become less negative. This voltage is fed to the "GAIN" control on the front panel of the amplifier. The wiper of the "GAIN" control is connected to the control input of U1A of the Linearizer/Control Circuit. The amplifier has maximum gain at approximately -12.5V control input; minimum gain occurs at 0V. The attenuation of A1U1 will increase as the output of A3U2B varies from -12.5V toward 0V. This will help to protect the unit in the event of input overdrive.

3.2.3 A4 One (1)-watt Amplifier (Schematic No. 1010591—Part of Schematic No. 1010749)

The A4 One (1)-watt Amplifier is assembled on a Teflon®/glass printed wiring board (PWB). It has three (3) GaAs FET gain stages. Each stage is input and output DC isolated by coupling capacitors. Resistive feedback is used from the drain to the gate of the GaAs FET to decrease the low-frequency gain. Shunt capacitive stubs are used to tune the amplifier. The drain of Q3 is matched to the output using a tapered transformer.

The GaAs FETs are operated in a depletion mode. They will conduct the maximum DC current with 0V bias on their gates and are normally operated with approximately -1V to -4V on their gates.

3.2.4 A5 Bias Control Circuit (Schematic No. 1010902—Part of Schematic No. 1010749)

The Bias Control Circuit controls the DC drain current of the three (3) FET stages in the A4 One (1)-watt Amplifier by varying the gate voltage of the RF stages. The Bias Control Circuit has a -5V input and a +16.5V input from the power supply.

All of the Bias Control Circuit stages operate in a similar manner; therefore, only the operation of the Q4 stage is described herein.

PNP transistor Q4 (2N3906) is used to control the DC current through the A4Q3 FET in the A4 One (1)-watt Amplifier. A reference voltage of 9.5V is established on the base of Q4 with the voltage divider network R7 (2.2K) and R12 (3.0K). There is a 18Ω resistor from the 16.5V line to the emitter of Q4 and also to the drain of A4Q3 in the A4 One (1)-watt Amplifier. Q4 will operate normally with approximately 10.2V on the emitter; this will occur with approximately 370mA through the 18Ω resistor R8. If the current through A4Q3 decreases, the drop across R8 will decrease, thereby increasing the emitter voltage of Q4; this will cause Q4 to conduct more, which will cause the gate voltage of A4Q3 to become more positive, which will cause A4Q4 to conduct more, thereby returning the voltage at the emitter of Q4 to 10.2V.

3.2.5 A6, A8, A9, A12, A13, A14, A15, A16, A17, A18, and A19 Quadrature-Coupled Amplifiers ("Quad Amps") (Schematic No. 1009163)

IC U1 is a voltage regulator set to 13.5V output with a current limit of approximately 2.2 amps. Q1 turns off the voltage regulator when the -5V supply voltage falls below approximately -3.5V. PNP transistors Q2 and Q5 regulate the DC current through Q3 and Q4, respectively, by sensing the voltage drop across 2.7Ω resistors R5 and R16 and varying the negative voltage on the gates of Q3 and Q4, thereby maintaining the drain current at approximately 1 amp. The DC operation of Q3 and Q4 can be checked on test points TP1 and TP2 without removing the unit's lid. The normal voltage on TP1 and TP2 without RF drive is 10.9 ±0.4V.

U2 and U3 are 90° quadrature couplers. U2 splits the input signal into two signals with a phase difference of 90°. U3 combines the RF outputs from Q3 and Q4 and is connected to the output connector J2. 50Ω termination resistors R17 and R18 absorb any difference signals and help to improve the input and output VSWR of the module. The module has a gain of 7.5dB or greater and delivers approximately 8 watts of RF power.

3.2.6 A7 Two-Way Splitter

A7 is a multi-section, broadband Wilkinson splitter. The input signal is split into two equal amplitude, in-phase signals. The amplitude of each signal is 3–3.5dB below the input signal when terminated in 50Ω loads.

3.2.7 A10, A11 Splitters

A10 and A11 are multi-section, multi-stage, broadband Wilkinson splitters. Each input signal is split into four equal amplitude, in-phase signals. The amplitude of each output signal should be 6–7dB below the input signal when they are terminated in 50Ω.

3.2.8 A20 Combiner

A20 is an Eight-Way Radial Combiner with impedance matching. The outputs of the A12, A13, A14, A15, A16, A17, A18, and A19 amplifiers are combined in A20 to yield a total power output approximately 9dB above the output of a single amplifier. The output of A20 is connected to the output connector of the Model 60S1G3.

3.3 POWER SUPPLY ASSEMBLY (Schematic No. 1010552)

The Power Supply Assembly consists of three switching power supplies—PS1, PS2, and PS3. These power supplies have a regulated output and auto-ranging on the input to automatically select the correct connections for the line voltage in use, either 90–132 or 180–264VAC, 50/60Hz.

PS1 is a triple-output power supply that provides +5V, +12V and –12V to power the Operate/Control Board. PS2 is also a triple-output power supply that provides +16.5V to the EFT drain supplies in the One (1)-Watt, Four (4)-Watt and Quadrature-Coupled amplifiers. PS2 also provides +24V and –24V. The +24V power supply powers the cooling fans; it is also regulated to +15V to operate the A3 Linearizer Control Board; it is also regulated to –5V to provide bias for the GaAs FETs in the One (1)-Watt, Four (4)-Watt and Quadrature-Coupled amplifiers. Relay K1 switches the AC input power to PS2 for local and remote amplifier operation. Fans B1, B2 and B3 supply air flow to cool the heat sink and the power supplies.

3.3.1 A21 Operate/Control Board (Schematic No. 1008597)

The A21 Operate/Control Board is a microcontroller-based printed wiring board (PWB) assembly that allows sensing and control of internal signals as well as remote personal computer (PC) control via on-board RS-232 and IEEE-488 data communications ports. The Operate/Control Board utilizes a state-of-the-art, Reduced Instruction Set Computing (RISC) microcontroller that can quickly and reliably perform all front panel control and monitoring tasks, thereby allowing real-time control of the Model 60S1G3 via either remote bus. Besides being reported remotely, all amplifier Faults are continuously monitored and indicated via the front panel VFD.

3.3.2 A22 Regulator/Control Board (Schematic No. 1009511)

The A15 Regulator/Control Board is comprised of DC regulators, comparators, and relays.

3.3.2.1 Relays K1, K2 and K3 are energized by the A14 Operate Control Board whenever the Model 60S1G3 is turned on, either locally or remotely. When energized, these relays supply DC power to ICs U1, U3 and U6 and Relay K1 in the Power Supply Assembly.

3.3.2.2 IC U1 supplies +15V to the A3 Linearizer Control Circuit. IC U6 supplies –15V to the A3 Linearizer Control Circuit. IC U3 supplies –5V to all of the Quad Amps, the A4 One (1)-Watt Amplifier, and the A6 Four (4)-Watt Amplifier.

SECTION IV

MAINTENANCE

4.1 GENERAL MAINTENANCE INFORMATION

The Model 60S1G3 is a relatively simple instrument that should require very little maintenance. It is built with printed wiring boards (PWBs) and solid state components in order to ensure long, trouble-free life. However, should a malfunction occur, special care must be taken when servicing the unit in order to avoid damage to the solid state components or the PWBs.

Since the unit's solid state components are soldered in place, substitution of components should not be resorted to unless there is some indication that they are faulty. In addition, when troubleshooting, care must be taken to avoid shorting amplifier voltages. Small bias changes may cause excessive dissipation or transients that could ruin the amplifier.

All components utilized in Amplifier Research instruments are conservatively operated to ensure maximum instrument reliability. Despite this, parts within an instrument may fail. In most cases, the instrument may be repaired immediately with a minimum of "down time." A systematic approach to troubleshooting can greatly simplify and thereby speed up the required repairs.

However, due to the critical importance of maintaining the amplifier's alignment, it is recommended that the unit be returned to the factory for part replacement and amplifier realignment when failure is caused by a breakdown of any of the components in the RF signal circuits. Shipping instructions are as follows.

Please ship the unit PREPAID via United Parcel Service (UPS) to:

Amplifier Research Corporation
160 School House Road
Souderton, PA 18964-9990

4.2 DISASSEMBLY PROCEDURE

⚠ CAUTION:

EXTREME CAUTION SHOULD BE EXERCISED WHEN TROUBLESHOOTING THIS UNIT, PARTICULARLY WHEN MEASURING VOLTAGES IN THE POWER SUPPLY SECTION, SINCE HAZARDOUS VOLTAGES EXIST IN THE UNIT THAT COULD CAUSE SERIOUS INJURY TO ANY PERSONNEL PERFORMING THE MEASUREMENTS.

The amplifier can be removed from its housing by removing four (4) screws from the front panel and four (4) screws from the back panel. The amplifier can then be slid from its housing. The top cover can be removed to gain access to the RF assemblies; the bottom cover can be removed to gain access to the power supplies.

4.3 Troubleshooting

⚠ CAUTION:

THE MICROWAVE TRANSISTORS USED IN THE MODEL 60S1G3 AMPLIFIER ARE GAAS FETS. THESE DEVICES ARE VERY RELIABLE WHEN INSTALLED IN A SUITABLE CIRCUIT, BUT THEY CAN BE EASILY DAMAGED BY IMPROPER TROUBLESHOOTING OR HANDLING TECHNIQUES. THE GATE JUNCTIONS OF THE GAAS FETS HAVE A HIGH INPUT IMPEDANCE AND ARE SUSCEPTIBLE TO STATIC DAMAGE OR DAMAGE DUE TO THE USE OF AN UNGROUNDED SOLDERING IRON. DO NOT TRY TO CHECK THE GAAS FETS WITH AN OHMMETER. USE CAUTION WHEN TROUBLESHOOTING THE GAAS FETS; DO NOT SHORT THE GATE TO THE GROUND OR TO THE DRAIN.

⚠ CAUTION:

USE CARE WHEN UNPACKING NEW GAAS FETS. THE GAAS FET PACKAGING SHOULD ONLY BE OPENED AT ELECTROSTATIC DISCHARGE (ESD)-APPROVED WORKSTATIONS, BY INDIVIDUALS WHO ARE FAMILIAR WITH THE HANDLING OF MICROWAVE GAAS FETS AND OTHER ESD-SENSITIVE DEVICES.

Troubleshooting the Model 60S1G3 in a logical manner can speed the solution to a problem. The settings of potentiometers ("pots"), capacitors ("caps"), or other variables should not be disturbed until other problems have been eliminated. Comparing the measured DC voltages to those shown on the schematics can solve many problems. Before measuring circuit voltages, first verify that the voltages to the circuits are correct.

Model 60S1G3 Troubleshooting Categories:

Subsection 4.3.1—"Power On" Indication Doesn't Display on Front Panel when **POWER** Switch is Depressed

Subsection 4.3.2—The Unit Cannot be Operated Remotely

Subsection 4.3.3—Thermal Fault

Subsection 4.3.4—Interlock Fault

Subsection 4.3.5—Voltage Faults

Subsection 4.3.6—Low or No Power Output (DC Tests)

Subsection 4.3.7—Low or No Power Output (RF Tests)

4.3 Troubleshooting *(continued)*

4.3.1 "Power On" Indication Doesn't Display on Front Panel when POWER Switch is Depressed (Schematic No. 1009506)

4.3.1.1 If the Model 60S1G3 is operating in an otherwise normal fashion, the front panel display or the wiring to it could be defective.

4.3.1.2 Check the **LOCAL/REMOTE** switch on the unit's front panel; it must be set to the **LOCAL** position in order to operate the front panel **POWER** switch. Check the circuit breaker on the unit's rear panel; it must be set to the "I" ("ON") position.

4.3.1.3 If the **"Power On"** indication is not displayed and the cooling fans (Blowers B1, B2, B3) are not running, check to see that the unit is plugged into a live outlet and that the AC line cord is plugged securely into the unit.

4.3.1.4 Check the output voltages from PS1; these voltages should be as follows:

PS1 J2, Pin 1	+12.0 ± 0.3VDC
PS1 J2, Pin 2	+ 5.0 ± 0.2VDC
PS1 J2, Pin 6	-12.0 ± 0.3VDC

4.3.1.5 If output voltages are not present on PS1, check the AC input to PS1.

4.3.1.6 Check the voltages to the A21 Operate/Control Board on connector A21 J1; the voltages should be as follows:

A14 J1, Pin 16	-12.0 ± 0.3VDC
A14 J1, Pin 29	+ 5.0 ± 0.2VDC
A14 J1, Pin 31	+12.0 ± 0.3VDC

4.3.1.7 Check the voltage on A21 J1, Pin 6; it should be ≥4V when the **POWER** switch (S1) is in the normal position and <0.1V when S1 is depressed. S1 is normally open; it is closed only when it is depressed. The amplifier should change state every time the **POWER** switch is depressed.

4.3.1.8 If all voltages are correct and the unit still does not operate, contact Amplifier Research to arrange for repair or replacement of the A21 Operate/Control Board.

4.3.2 The Unit Cannot be Operated Remotely

4.3.2.1 Verify that the front panel **LOCAL/REMOTE** switch is set to the **REMOTE** position.

4.3.2.2 Verify that the unit operates locally by resetting the **LOCAL/REMOTE** switch to the **LOCAL** position; if the unit does not operate locally, see subsection **4.3.1** of this manual.

4.3 Troubleshooting *(continued)*

4.3.2 The Unit Cannot be Operated Remotely *(continued)*

4.3.2.3 Check the position of the "**ADDRESS**" switch assembly (SW1) on the A21 Operate/Control Board; this assembly can be accessed through the unit's rear panel. Check to see that these switches are properly set for either RS-232 or IEEE-488 operation, as desired. (See subsection **2.2.2** of this manual for the proper "**ADDRESS**" switch settings.) (**Note:** Address switches are only read at unit power-up; remove and re-apply AC power (i.e., reset the circuit breaker) after changes are made.)

4.3.3 Thermal Fault (Schematic No 1010522)

During a Thermal Fault, the front panel display should read "**Thermal Fault.**"

4.3.3.1 Try to reset the unit; if the unit resets and operates normally, check to see that the cooling fans (B1, B2, B3) are operating normally and that the air inlet on the bottom of the unit and the air outlets on the rear of the unit are not blocked.

4.3.3.2 If the unit does not reset and the cooling fans are operating normally, check the voltage at the A21 Operate/Control Board, J1, Pin 4; it should be ≤0.1V.

4.3.3.3 If the voltage on A21 J1, Pin 4 is high, check the thermal daisy chain through S2 and S1, S3, S4 to ground.

4.3.4 Interlock Fault (Schematic No. 1010552)

The Model 60S1G3 is equipped with an interlock connector, which is located on the rear panel. The interlock circuit can be used to sense the openings of doors to screen rooms, test chambers, and so forth, and to turn off RF energy when these doors are opened.

Note: The Model 60S1G3 is shipped with a mating connector, which has a jumper between Pins 1 and 8, installed in the rear panel interlock connector. The unit will not operate unless the interlock circuit is closed.

4.3.4.1 In the event of an Interlock Fault, the front panel display should read "**INTERLOCK FAULT.**"

4.3.4.2 Check to see if it is safe to be power up the unit—are there personnel present in the screen room, or are doors to the screen room open?

4.3.4.3 After checking for safety, try to clear the Interlock Fault from the front panel by using the **RESET** switch.

4.3.4.4 If the Interlock Fault will not clear, check for continuity in the External Interlock Circuit (Pin 1 to Pin 8 in the connector, which mate with J2 in the rear panel).

4.3 Troubleshooting *(continued)*

4.3.4 Interlock Fault (Schematic No. 1010552) *(continued)*

4.3.4.5 Check the voltage on A22 J1, Pin 18; it should be ≥4.0V.

4.3.4.6 Check the voltage on A21 J1, Pin 20; it should be ≥4.0V.

4.3.4.7 If all of the above voltages are correct and the unit still will not reset, check for defective wiring and/or PWB connections, then try the **RESET** switch again. If the unit still will not reset, the A21 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A21 Operate/Control Board.

4.3.5 Voltage Faults (Schematic Nos. 1010552 and 1009511)

The Model 60S1G3's fault circuits sense four voltage faults: **-5V, -15V, +15V, and +16.5V**. The -5V and -15V fault circuits are located on the A22 Regulator Control Board. The +15V and +16.5V fault circuits are located on the A21 Operate/Control Board.

4.3.5.1 -5V Faults: -5V faults are sensed by a fault circuit on the A22 Regulator/Control Board.

4.3.5.2 A22 U5B is a comparator that is used to sense -5V faults. This comparator's output is usually low.

4.3.5.3 The output of A22 U5B should go high if the -5V power supply ≤ 3.8V.

4.3.5.4 The output of A22 U5B is fed to the A21 Operate/Control Board via A21 J1, Pin 25.

4.3.5.5 If the output of A22 U5B is low and the -5V fault cannot be cleared, and the amplifier cannot be reset, then the A21 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A21 Operate/Control Board.

4.3.5.6 -15V Faults: -15V faults are sensed by a fault circuit on the A22 Regulator/Control Board.

4.3.5.7 A22 U5A is a comparator that is used to sense -15V faults. This comparator's output is usually low.

4.3.5.8 The output of A22 U5A should go high if the-15V power supply is ≤-12.2V.

4.3.5.9 The output of A22 U5A is fed to the A14 Operate/Control Board via A21 J1, Pin 40.

4.3.5.10 If the output of A22 U5A is low and the -15V fault cannot be cleared, and the amplifier cannot be reset, then the A21 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A21 Operate/Control Board.

4.3 Troubleshooting *(continued)*

4.3.5 Voltage Faults (Schematic Nos. 1010552 and 1009511) *(continued)*

4.3.5.11 +15V Faults: +15V faults are sensed by a fault circuit on the A21 Operate/Control Board.

4.3.5.12 If there is a +15V fault that cannot be cleared, check the voltage at A21 J1, Pin 9. If the voltage is >12.7V and the fault will not clear, check the adjustment of R22 on the A21 Operate/Control Board. If the problem cannot be corrected by adjusting R22, then the Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A21 Operate/Control Board.

4.3.5.13 +16.5V Faults: +16.5V faults are detected by a fault circuit on the A21 Operate/Control Board.

4.3.5.14 If there is a +16.5V fault that cannot be cleared, check the voltage on A21 J1, Pin 10. If the voltage is >12.7V and the fault will not clear, check the adjustment of R23 on the Operate/Control Board.

4.3.5.15 If the voltage on A21 J1, Pin 10 is normal (>12.7V) and the fault cannot be cleared by adjusting R23, then the A21 Operate/Control Board is defective. Contact Amplifier Research to arrange for repair or replacement of the A21 Operate/Control Board.

4.3.6 Low or No Power Output (DC Tests) (Schematic No. 1010552)

All indicators on the Model 60S1G3 are normal, the front panel display reads **"Power On,"** and the cooling fans (Blowers B1 and B2, B3) are operating.

4.3.6.1 Check the position of the RF Gain control—is it set to maximum gain?

4.3.6.2 Check the RF input to the unit—is it the correct amplitude and frequency?

4.3.6.3 Check the RF output connection from the unit—is it correctly connected to the load? Is the coaxial cable okay?

4.3.6.4 Check the voltages on Connector J1 of the A3 Linearizer Control Circuit. Troubleshoot any incorrect voltages.

A3 J1, Pin 4 -15 ± 0.4V
A3 J1, Pin 5 15 ± 0.4V
A3 J1, Pin 6 -12.5 ± 1.5V (RF Gain control at maximum gain, input signal <-5dBm).

4.3 Troubleshooting *(continued)*

4.3.6 Low or No Power Output (DC Tests) (Schematic No. 1010552) *(continued)*

4.3.6.5 Check the voltages on the feed-through capacitors of the A1 Variable Gain Amplifier with the RF Gain control set for maximum gain. Troubleshoot any incorrect voltages.

A1 C12	-0.7 to -3.5V
A1 C13	4.3 ± 0.5V
A1 C11	-0.1 ± 0.05V
A1 C10	-1.5 ± 0.5V
A1 C9	-4.0 ± 1.0V

4.3.6.6 Check the voltages supplied to the A5 Bias Control Board. Troubleshoot any incorrect voltages.

A5, Pin 3	16.5 ± 0.5V
A5, Pin 1	-5 ± 0.4V

4.3.6.7 Check the voltages on the feed-through capacitors of the A4 One (1)-Watt Amplifier. Troubleshoot any incorrect voltages.

C3, C5, C7	-0.7 to -3.5V
A4 C4	7.6 ± 0.5V
A4 C6	10.2 ± 0.5V
A4 C8	10.2 ± 0.5V

4.3.6.8 Check the voltage on TP1 on the A6 Four (4)-Watt Amplifier; the voltage should be 10.4 ± 0.3V. If the voltage on TP1 is low, check the voltages on C1 and C4 of that amplifier.

4.3.6.9 Check the voltages on TP1 (C21) and TP2 (C22) on the A6, A8, A9, A12, A13, A14, A15, A16, A17, A18 and A19 Quadrature-Coupled Amplifiers ("Quad Amps"); the voltage should be 10.4 ± 0.3V. If any of the voltages on TP1 and TP2 are low, check the voltages on C1 and C4 of that amplifier.

TP1, TP2	10.9 ± 0.3V
C1	16.5 ± 0.3V
C4	-5 ± 0.3V

4.3.7 Low or No Power Output (RF Test) (Schematic No. 1010552)

Note: The DC Tests specified in subsections **4.3.6.1–4.3.6.8** should be completed before conducting the RF tests specified in the following subsections.

Phase matching must be maintained from the output of the A7 Two-Way Splitter to the input of the A20 Eight-Way Combiner; if coaxial cables are removed, they must be reinstalled in the same locations from which they were removed. Replacement coaxial cable assemblies must be the same lengths as the original ones.

4.3.6.2 Check the RF input to the unit—is it the correct amplitude and frequency?

4.3.6.3 Check the RF output connection from the unit—is it correctly connected to the load? Is the coaxial cable okay? Check the DC voltages at the following points:

4.3.6.4 Check the voltages on Connector J1 of the A3 Linearizer Control Circuit. Troubleshoot any incorrect voltages.

A3 J1, Pin 4 -15 ± 0.4V
A3 J1, Pin 5 15 ± 0.4V
A3 J1, Pin 6 -12.5 ± 1.5V ("GAIN" control at maximum gain. Input signal <-5dBm).

4.3.6.5 Check the voltages on the feed-through caps of the A1 Variable Gain Amplifier with the RF Gain control set for maximum gain. Troubleshoot any incorrect voltages.

A1 C12	-0.7 to -3.5V
A1 C13	4.3 ± 0.5V
A1 C11	-0.1 ± 0.05V
A1 C10	-1.5 ± 0.5V
A1 C9	-4.0 ± 1.0V

4.3.6.6 Check the voltages supplied to the A5 Bias Control Board. Troubleshoot any incorrect voltages.

A5, Pin 3	+16.5 ± 0.5V
A5, Pin 1	-5 ± 0.4V

4.3.6.7 Check the voltages on the feed-through caps of the A4 One (1)-watt Amplifier. Troubleshoot any incorrect voltages.

C3, C5, C7	-0.7 to -3.5V
A4 C4	7.6 ± 0.5V
A4 C6	10.2 ± 0.5V
A4 C8	10.2 ± 0.5V

4.3.6.8 Check the voltages on TP1 (C21) and TP2 (C22) on the A6, A8, A9, A12, A13, A14, A15, A16, A17, A18, and A19 Quadrature-Coupled Amplifiers ("Quad Amps"). The voltage should be 10.4 ± 0.3V. If any of the voltages on TP1 and TP2 are low, check the voltages on C1 and C4 of that amplifier.

TP1, TP2	10.9 ± 0.3V
C1	16.5 ± 0.3V
C4	-5 ± 0.3V

4.3.7 Low or No Power Output (RF Test) (Schematic No. 1010552)

NOTE: The DC Tests specified in Paragraphs 4.3.6–4.3.6.8 should be completed before conducting the RF tests specified in the following paragraphs.

Phase matching must be maintained from the output of the A7 Two-Way Splitter to the input of the A20 Eight-Way Combiner; if coaxial cables are removed, they must be reinstalled in the same location from which they were removed. Replacement coaxial cable assemblies must be the same lengths as the original ones.

4.3.7.1 The Model 60S1G3's typical Gain Response is shown in **Figure 4.3.7.1.** The actual gain may vary considerably from that shown in Figure 4.3.7.1, but it should be ≥48dB.

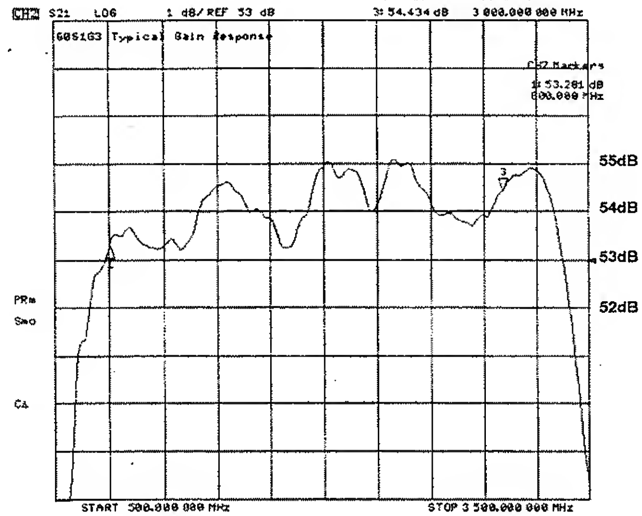


Figure 4.3.7.1
Typical Gain Response

NOTE: If the overall gain is low, the amplifier chain can be separated at the input to the A7 Two-Way Splitter and the gain checked from the input to the A7 Two-Way Splitter to the "OUTPUT" connector on the unit's front panel.

4.3.7.2 Remove the coaxial cable from the output of the A6 Quad Amp to the input of the A7 Two-Way Splitter. The typical response from the input of the A7 Two-Way Splitter to the "OUTPUT" connector on the unit's front panel is shown in **Figure 4.3.7.2.**

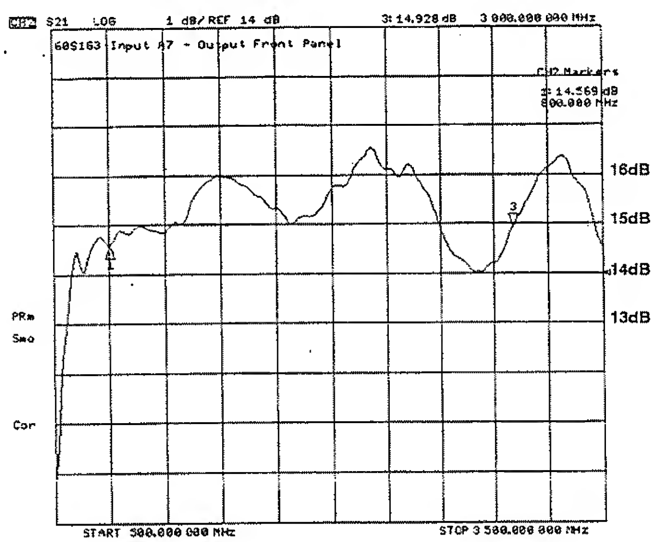


Figure 4.3.7.2
Typical Response: Input A7–Output Front Panel

If the response is normal, see **Paragraph 4.3.7.8.** If the response is abnormal, perform the following tests.

4.3.7.3 If the gain is slightly low (i.e., several dB below typical), try disconnecting the inputs from the A12, A13, A14, A15, A16, A17, A18, and A19 Quad Amps one at a time, then reconnect them. Note the difference in response when disconnecting the Quad Amps; if any Quad Amp causes less of a change in gain than the others, check the Quad Amp, coaxial cable, and so forth associated with that Quad Amp. Typical Quad Amp Response is shown in **Figure 4.3.7.3.**

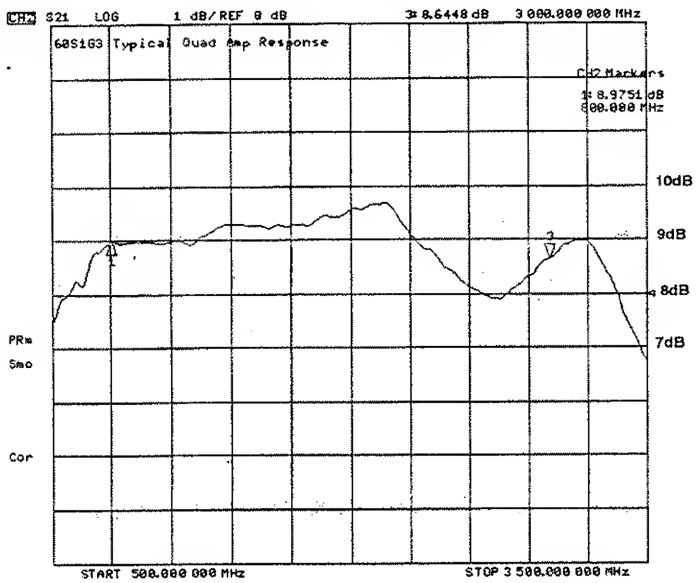


Figure 4.3.7.3
Typical Quad Amp Response

4.3.7.4 If the gain is 5dB or more below the typical response, do the following:

- Disconnect the coaxial cable from the input of the A8 Quad Amp, and note the results.
- Reconnect the coaxial cable from the input of A8 and disconnect the coaxial cable from the input of the A9 Quad Amp; the results should be similar. If not, check the side that made the least difference. Check the Two-Way Splitter, the Four-Way Splitter, the Quad Amp, and so forth.

4.3.7.5 A typical Two-Way Splitter Insertion Loss is shown in Figure 4.3.7.5. The unused port must be terminated when checking the insertion loss.

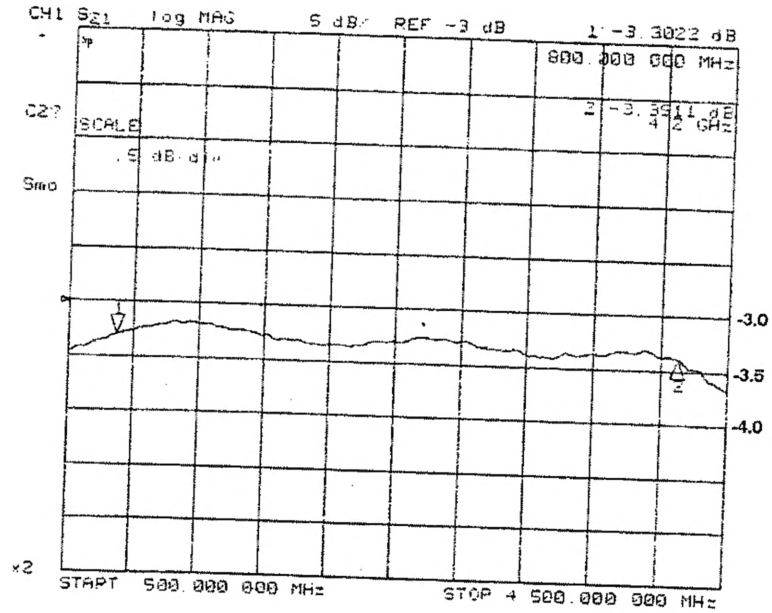


Figure 4.3.7.5
Typical Two-Way Splitter Insertion Loss

4.3.7.6 A typical Four-Way Splitter Insertion Loss is shown in **Figure 4.3.7.6.** The unused port must be terminated when checking the insertion loss.

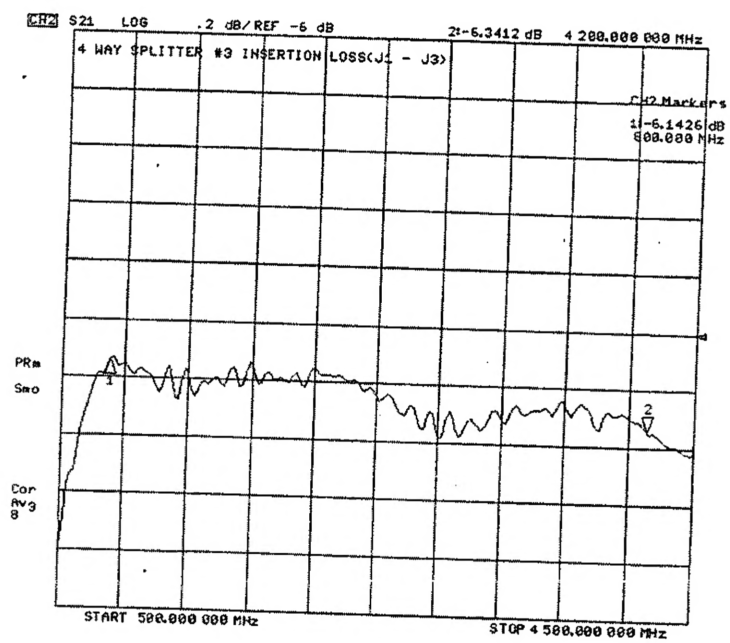


Figure 4.3.7.6
Typical Four-Way Splitter Insertion Loss

4.3.7.7 A typical Eight-Way Combiner Insertion Loss and Combined Port Return Loss is shown in **Figure 4.3.7.7.** The unused port must be terminated when checking the Insertion Loss.

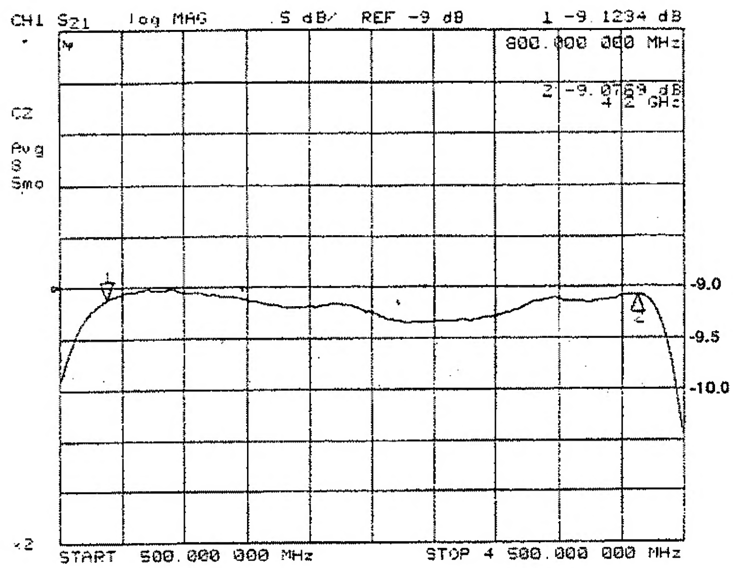


Figure 4.3.7.7
Typical Eight-Way Combiner Insertion Loss

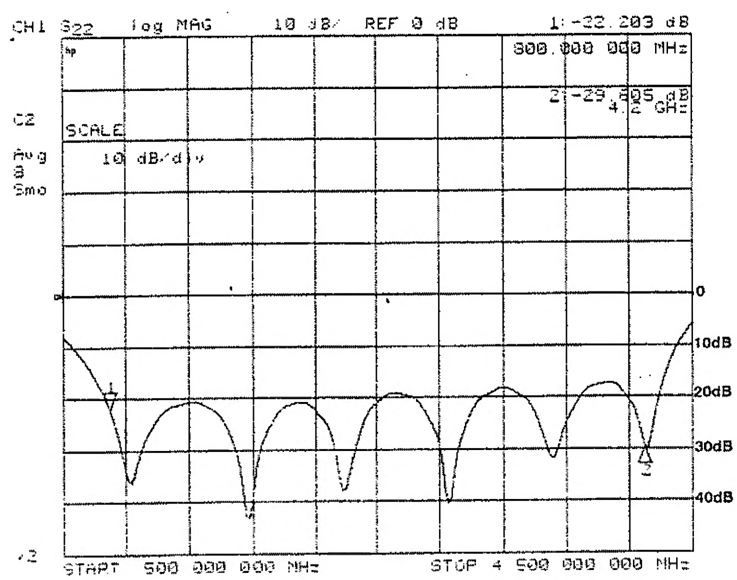


Figure 4.3.7.7
Typical Eight-Way Combiner Return Loss: Combined Output Port

NOTE: The Return Loss of the Eight-Way Combiner's combined output port is typically better than 17dB (see Figure 4.3.7.7). The Return Loss of the Eight-Way Combiner's eight input ports is approximately 2dB when one port is driven.

4.3.7.8 If the response of the output stages (A7 Two-Way Splitter input to front panel "OUTPUT") is normal, check the response of the A6 Quad Amp (see **Figure 4.3.7.8**).

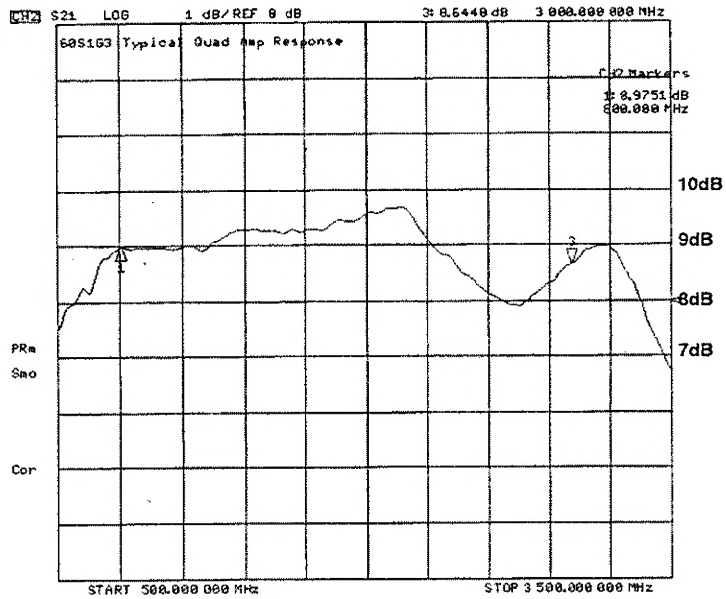


Figure 4.3.7.8
Typical Quad Amp Response

NOTE: The A4 One (1)-watt Amplifier's response or the A1 Variable Gain Amplifier's response may differ considerably—particularly in flatness—from the typical responses shown in the following Figures (4.3.7.9 and 4.3.7.10).

4.3.7.9 The typical response for the A4 One (1)-watt Amplifier is shown in **Figure 4.3.7.9.**

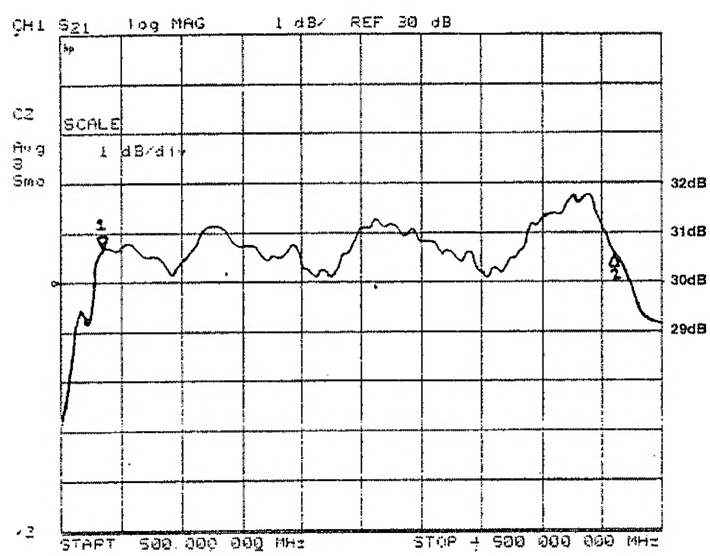


Figure 4.3.7.9
Typical A4 One (1)-Watt Amplifier Response

4.3.7.10 The typical response for the A1 Variable Gain Amplifier (at maximum gain setting) is shown in **Figure 4.3.7.10.**

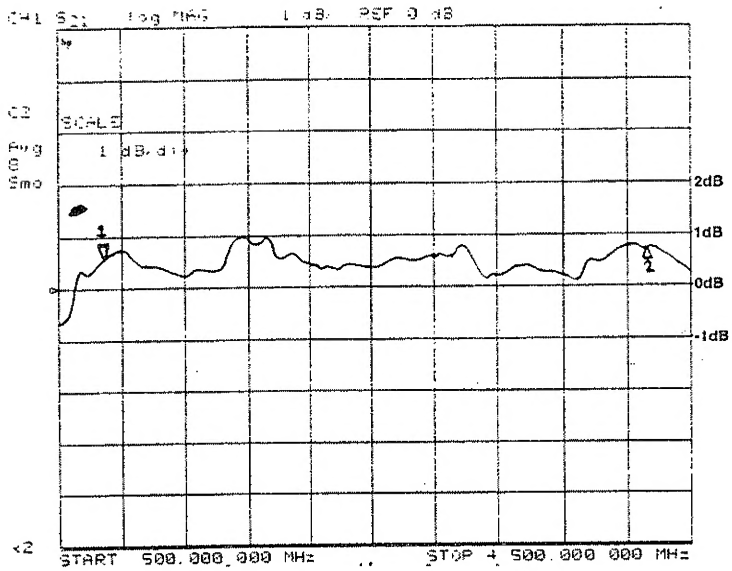


Figure 4.3.7.10
Typical A1 Variable Gain Amplifier Response